uplink signals from a mobile station may not always be the best beam for communicating downlink signals to that mobile station.

Still another technical advantage includes a smart antenna apparatus operable to select a best beam in real time. In other words, the smart antenna apparatus is operable to select a beam based on uplink signals received in a particular time slot and switch to that beam during the same time slot. Thus, the smart antenna apparatus is operable to select a best beam when receiving an initial communication from a mobile station, such as a random access channel (RACH) burst. This increases the effective range of a base station transceiver for identifying initial signals from a mobile station.

Other technical advantages are readily apparent to one skilled in the art from the following figures, descriptions, and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the invention, and for further features and advantages, reference is now made to the following description, taken in conjunction with the accompanying drawings, in which:

FIG. **1** illustrates a wireless communication system including a smart antenna system and a base station in accordance with an embodiment of the present invention;

FIG. **2** illustrates the general architecture and operation of the smart antenna system of FIG. **1** including a smart antenna apparatus and an antenna unit;

FIG. **3** illustrates a receiving system of the smart antenna apparatus of FIG. **2**;

FIG. **4** illustrates a processing system of the smart antenna apparatus of FIG. **2**;

FIG. **5** illustrates a system for monitoring control signals being communicated from a base station transceiver to mobile stations and synchronizing the smart antenna apparatus with the base station transceiver using the control signals in accordance with an embodiment of the present invention;

FIG. **6** illustrates a method for monitoring control signals being communicated from a base station transceiver to mobile stations in accordance with an embodiment of the present invention;

FIG. **7** illustrates a method for synchronizing the smart antenna apparatus with the base station transceiver during start-up in accordance with an embodiment of the present invention;

FIG. **8** illustrates a method for maintaining the smart antenna apparatus in synchronization with the base station transceiver during steady-state operation in accordance with an embodiment of the present invention;

FIG. **9** illustrates a system for monitoring signaling information being communicated via an interface between a base station transceiver and a base station controller in accordance with an embodiment of the present invention;

FIG. **10** illustrates a method for monitoring signaling information being communicated via the interface illustrated in FIG. **9**;

FIG. **11** illustrates a system for determining beam selections with the smart antenna apparatus of FIG. **2**;

FIG. **12** illustrates a system for determining fast decision beam selections in accordance with an embodiment of the present invention;

FIG. **13** illustrates a method for determining fast decision beam selections in accordance with an embodiment of the present invention;

FIG. **14** illustrates a system for controlling the gain settings for each beam receiver for determining fast decision beam selections in accordance with an embodiment of the present invention;

FIG. **15** illustrates a method for controlling the gain settings for each beam receiver for determining fast decision beam selections in accordance with an embodiment of the present invention;

FIG. **16** illustrates a system for determining smart decision beam selections including a smart decision beam selection module in accordance with an embodiment of the present invention;

FIG. **17** illustrates the architecture and operation of the smart decision beam selection module of FIG. **16** in accordance with an embodiment of the present invention;

FIG. **18** illustrates a method for determining smart decision beam selections in accordance with an embodiment of the present invention;

FIG. **19** illustrates a correlation module for determining a correlation quality of each uplink beam for use in determining smart decision beam selections in accordance with an embodiment of the present invention;

FIG. **20** illustrates a method for determining a correlation quality uplink beams by correlating a signal sequence in each uplink beam with one or more known training sequences in accordance with an embodiment of the present invention;

FIG. **21** illustrates a method for determining a correlation quality uplink beams by correlating a signal sequence in each uplink beam with one or more known training sequences in accordance with an embodiment of the present invention;

FIG. **22** illustrates a system for determining whether to use a fast decision beam selection or a smart decision beam selection for a particular time slot in accordance with an embodiment of the present invention; and

FIG. **23** illustrates a method for determining whether to use a fast decision beam selection or a smart decision beam selection for a particular time slot in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

Example embodiments of the present invention and their advantages are best understood by referring now to FIGS. **1** through **23** of the drawings, in which like numerals refer to like parts.

Generally, a smart antenna system is provided as an add-on to an existing base station in a wireless communications system. The smart antenna system combines an antenna unit that may include a smart antenna array and optionally a backup sector antenna with a smart antenna apparatus having signal processing capabilities to receive and transmit signals in a spatially sensitive manner, or in other words, along one or more selected beams. The smart antenna apparatus is operable to execute one or more algorithms, based on a number of inputs, to select an uplink beam for uplink signals and a downlink beam for downlink signals. The uplink beam is used to communicate uplink signals received from a mobile station to a base station transceiver. The downlink beam is used to communicate downlink signals from the base station transceiver to the mobile station.

The smart antenna apparatus may include a fast decision beam selection module to make beam selections in substantially real time and a smart decision beam selection module to make beam selections based on more input and processing. The smart antenna apparatus may be operable to determine whether to use the results from the fast decision beam selection module or the smart decision beam selection module